

**Amendments to the Claims:**

Please amend claims 3, 10, 12, 16, 22, 23, and 26 as set forth below.

This listing of claims will replace all prior versions, and listings of claims in the application:

**Listing of Claims:**

- 1                   1. (Original) In a disk drive control circuit wherein, during normal operation,  
2 control logic controls a plurality of switching elements to provide electrical power to a spindle  
3 motor and head motor of the disk drive from a voltage source coupled to first and second voltage  
4 supply nodes, the spindle motor having a set of motor windings to which the electric power is  
5 applied to rotate the spindle motor, the improvement wherein:  
6                   the control logic is configured to enter a regenerative braking state during normal  
7 operation where the switching elements are controlled to isolate the spindle motor from the first  
8 voltage supply node and cause regenerative braking of the spindle motor so that kinetic energy  
9 due to rotation of the spindle motor is converted to electrical power that is supplied to the head  
10 motor by virtue of inductance of one or more motor windings in the set.
- 1                   2. (Original) The improvement of claim 1 wherein:  
2                   said control logic is implemented in a self-contained HDD system having a  
3 battery;  
4                   said control logic is further configured to sense a commanded power-down  
5 condition, and in response to which causes regenerative braking of the spindle motor so that  
6 kinetic energy due to rotation of the spindle motor is converted to electrical power that is used to  
7 recharge the battery.
- 1                   3. (Currently amended) ~~The improvement of claim 1 wherein~~ In a disk drive  
2 control circuit wherein, during normal operation, control logic controls a plurality of switching  
3 elements to provide electrical power to a spindle motor and head motor of the disk drive from a  
4 voltage source coupled to first and second voltage supply nodes, the spindle motor having a set  
5 of motor windings to which the electric power is applied to rotate the spindle motor, the  
6 improvement wherein:

7           the control logic is configured to enter a regenerative braking state during normal  
8   operation where the switching elements are controlled to isolate the spindle motor from the first  
9   voltage supply node and cause regenerative braking of the spindle motor so that kinetic energy  
10   due to rotation of the spindle motor is converted to electrical power that is supplied to the head  
11   motor by virtue of inductance of one or more motor windings in the set; and

12           said control logic is further configured to sense a condition where the spindle  
13   motor speed falls outside a desired range, and in so sensing, prevent the regenerative state from  
14   being entered.

1           4. (Original) The improvement of claim 1 wherein:  
2           at least one of the switching elements is configured as part of a boost circuit  
3   coupled between the first voltage supply node and the head motor; and  
4           the control logic activates said boost circuit during said regenerative braking state.

1           5. (Original) The improvement of claim 1 wherein the control logic enters said  
2   regenerative braking state for a seek operation to be performed by the disk drive.

1           6. (Original) The improvement of claim 1 wherein:  
2           the spindle motor is a multi-phase motor having a plurality of commutation states;  
3           the control logic is configured to enter regenerative braking states for at least  
4   some of said commutation states; and  
5           the control logic enters respective regenerative braking states for each of a  
6   contiguous sequence of commutation states.

1           7. (Original) The improvement of claim 1 wherein:  
2           the spindle motor is a multi-phase motor having a plurality of commutation states;  
3           the control logic is configured to enter regenerative braking states for at least  
4   some of said commutation states; and  
5           the control logic enters respective regenerative braking states for each of a non-  
6   contiguous sequence of commutation states.

1           8. (Original) In a circuit for controlling power supplied to a spindle motor and a  
2   head motor of a disk drive from a voltage source coupled to first and second voltage supply

3 nodes, wherein during normal operation the circuit provides a conduction path through a  
4 switching element to a motor supply node, and includes a spindle motor drive circuit and a head  
5 drive motor drive circuit that provide conduction paths from the motor supply node to the second  
6 voltage supply node to energize the spindle motor and the head motor, the improvement  
7 comprising:

8                   a control circuit that operates at specified times during normal operation to  
9                   cause the switching element to prevent current flow between the first  
10                  voltage supply node and the motor supply node,  
11                  configure the spindle motor drive circuit to cease driving the spindle  
12                  motor and allow the spindle motor to supply current to the motor supply node, and  
13                  configure the head motor drive circuit to energize the head motor with  
14                  current flowing from said first voltage supply node and current supplied by the spindle  
15                  motor.

1                   9. (Original) The improvement of claim 8, and further comprising a boost circuit  
2 coupled between said first voltage supply node and said motor supply node.

1                   10. (Currently amended) The improvement of claim 9 wherein said control  
2 circuit further operates at said specified times during normal operation to activate the boost  
3 circuit to allow current to flow from the first voltage supply node to the motor supply ~~node~~ node.

1                   11. (Original) The improvement of claim 9 wherein said boost circuit is a  
2 synchronous boost converter comprising an inductor and at least one switching element.

1                   12. (Currently amended) A circuit for controlling a spindle motor and a head  
2 motor of a disk drive, the circuit comprising:  
3                   first and second voltage supply nodes;  
4                   a switching element coupled between said first voltage supply node and a ~~node~~,  
5 ~~referred to as the~~ motor supply node;  
6                   a spindle motor drive circuit coupled between said motor supply node and said  
7 second voltage supply node, said spindle motor drive circuit including nodes for coupling to  
8 respective spindle motor connection nodes;

9 a head motor drive circuit coupled between said motor supply node and said  
10 second voltage supply node, said head motor drive circuit including nodes for coupling to  
11 respective head motor connection nodes;

12 a boost circuit coupled between said first voltage supply node and said motor  
13 supply node; and

14 a control circuit coupled to said switching element, said spindle motor drive  
15 circuit, said head motor drive circuit, and said boost circuit;

16 said control circuit being configured with a set of one or more spindle motor drive  
17 states wherein:

18 said switching element is set to allow current flow between said first  
19 voltage supply node and said motor supply node,

20 said spindle motor drive circuit is configured to energize the spindle motor  
21 with current flowing between said motor supply node and said second voltage supply  
22 node, and

23 said boost circuit is not activated;

24 said control circuit being configured with a set of one or more regenerative  
25 braking states wherein:

26 said switching element is set to prevent current flow between said first  
27 voltage supply node and said motor supply node,

28 said spindle motor drive circuit is configured to allow the spindle motor to  
29 supply current to said motor supply node,

30 said boost circuit is activated to allow current to flow from said first  
31 voltage supply node to said motor supply node, and

32 said head motor drive circuit is configured to energize the head motor with  
33 current flowing from said first voltage supply node and current supplied by the spindle  
34 motor.

1 13. (Original) The circuit of claim 12 wherein said control circuit enters at least  
2 one of said regenerative braking states for a seek operation to be performed by the disk drive.

1                   14. (Original) The circuit of claim 12 wherein:  
2                   the spindle motor is a multi-phase motor having a plurality of commutation states;  
3                   said set of regenerative braking states includes regenerative braking states for at  
4 least some of said commutation states; and  
5                   said control logic is configured to enter respective regenerative braking states for  
6 each of a contiguous sequence of commutation states.

1                   15. (Original) The circuit of claim 12 wherein:  
2                   the spindle motor is a multi-phase motor having a plurality of commutation states;  
3                   said set of regenerative braking states includes regenerative braking states for at  
4 least some of said commutation states; and  
5                   said control logic is configured to enter respective regenerative braking states for  
6 each of a non-contiguous sequence of commutation states.

1                   16. (Currently amended) A hard disk drive circuit for controlling a spindle motor  
2 and a head motor, the circuit comprising:  
3                   first and second voltage supply nodes;  
4                   a selective isolation switching element coupled between said first voltage supply  
5 node and a ~~node, referred to as the~~ motor supply node;  
6                   first and second bridge circuits coupled in parallel between said motor supply  
7 node and said second voltage supply node;  
8                   said first bridge circuit including a plurality of parallel branches, each branch  
9 including at least one switching element and an intermediate spindle motor connection node for  
10 coupling to a respective node of the spindle motor;  
11                   said second bridge circuit having a plurality of parallel branches, each branch  
12 including at least one switching element and an intermediate head motor connection node for  
13 coupling to a respective node of the head motor;  
14                   each switching element having a respective control input responsive to input  
15 signals for controlling a state of that switching element;  
16                   a boost circuit coupled between said first voltage supply node and said motor  
17 supply node, said boost circuit having a control input; and

control logic coupled to said control input of said selective isolation switching element, to said control inputs of said switching elements in said first and second bridges, and to said control input of said boost circuit;

said control logic being configured to generate control signals during normal operation for operation in a set of one or more spindle motor drive states wherein:

said selective isolation switching element is set to allow current flow between said first voltage supply node and said motor supply node,

said first bridge circuit is configured to energize the spindle motor with current flowing between said motor supply node and said second voltage supply node, and

said boost circuit is not activated;

said control circuit being configured to generate control signals during normal operation for operation in a set of one or more regenerative braking states wherein:

said selective isolation switching element is set to prevent current flow between said first voltage supply node and said motor supply node,

said first bridge circuit is configured to allow the spindle motor to supply current to said motor supply node,

said boost circuit is activated to allow current to flow from said first voltage supply node to said motor supply node, and

said second bridge circuit is configured to energize the head motor with current flowing from said first voltage supply node and current supplied by the spindle motor.

17. (Original) The circuit of claim 16 wherein said control circuit is further configured to sense a condition where the spindle motor speed falls outside a desired range, and in so sensing, prevent the regenerative state from being entered .

18. (Original) The circuit of claim 16 wherein said control circuit enters at least one of said regenerative braking states for a seek operation to be performed by the disk drive.

19. (Original) The circuit of claim 16 wherein:  
the spindle motor is a multi-phase motor having a plurality of commutation states;

3                   said set of regenerative braking states includes regenerative braking states for at  
4   least some of said commutation states; and

5                   said control logic is configured to generate control signals for operation in  
6   respective regenerative braking states for each of a contiguous sequence of commutation states.

1                   20. (Original) The circuit of claim 16 wherein:  
2                   the spindle motor is a multi-phase motor having a plurality of commutation states;  
3                   said set of regenerative braking states includes regenerative braking states for at  
4   least some of said commutation states; and  
5                   said control logic is configured to generate control signals for operation in  
6   respective regenerative braking states for each of a non-contiguous sequence of commutation  
7   states.

1                   21. (Original) The circuit of claim 16 wherein said boost circuit is a synchronous  
2   boost converter comprising an inductor and at least one switching element.

1                   22. (Currently amended) A chip set for use in a disk drive having a spindle  
2   motor and a head motor, the spindle motor having a set of motor windings to which electric  
3   power is applied to rotate the spindle motor, the chip set comprising:  
4                   a plurality of switching elements incorporated in one or more semiconductor  
5   devices; and  
6                   an integrated circuit device having drive control circuitry, wherein, during normal  
7   operation, said control logic controls said plurality of switching elements to provide electrical  
8   power to the spindle motor windings and the head motor from a voltage source coupled to first  
9   and second voltage supply nodes;  
10                  said control logic being configured to enter a regenerative braking state during  
11   normal operation, wherein:  
12                  at least one of the switching elements is controlled to isolate the spindle  
13   motor from the first voltage supply node; and  
14                  at least some of the switching elements are controlled to cause  
15   regenerative braking of the spindle motor so that kinetic energy due to rotation of the

16 spindle motor is converted to electrical power that is supplied to the head motor by virtue  
17 of inductance of one or more motor windings in the set.

1 23. (Currently amended) ~~The chip set of claim 22 wherein~~ A chip set for use in a  
2 disk drive having a spindle motor and a head motor, the spindle motor having a set of motor  
3 windings to which electric power is applied to rotate the spindle motor, the chip set comprising:  
4 a plurality of switching elements incorporated in one or more semiconductor  
5 devices; and  
6 an integrated circuit device having drive control circuitry, wherein, during normal  
7 operation, control logic controls said plurality of switching elements to provide electrical power  
8 to the spindle motor windings and the head motor from a voltage source coupled to first and  
9 second voltage supply nodes, wherein:  
10 said control logic is configured to enter a regenerative braking state during normal  
11 operation, with  
12 at least one of the switching elements being controlled to isolate the  
13 spindle motor from the first voltage supply node, and  
14 at least some of the switching elements being controlled to cause  
15 regenerative braking of the spindle motor so that kinetic energy due to rotation of the  
16 spindle motor is converted to electrical power that is supplied to the head motor by virtue  
17 of inductance of one or more motor windings in the set; and  
18 said control logic is further configured to sense a condition where the spindle  
19 motor speed falls outside a desired range, and in so sensing, prevent the regenerative state from  
20 being entered- entered.

1 24. (Original) The chip set of claim 22 wherein said plurality of switching  
2 elements are incorporated in a single semiconductor chip.

1 25. (Original) The chip set of claim 22 wherein said plurality of switching  
2 elements are incorporated in more than one semiconductor chip.

1 26. (Currently amended) A disk drive comprising:  
2 disk having concentric tracks for storing information;



3 a head for reading and/or writing information to said disk;  
4 a spindle motor having a set of windings for rotating said disk in response to  
5 current supplied to said windings;  
6 a head motor for moving said head to access selected tracks on said disk;  
7 a spindle motor drive circuit;  
8 a head motor drive circuit;  
9 first and second voltage supply nodes for connection to a source of electrical  
10 power for said spindle motor and said head motor;  
11 a ~~switching element, referred to as the~~ selective isolation switching element,  
12 coupled between said first supply node and an intermediate ~~node, referred to as the~~ motor supply  
13 node, said spindle motor drive circuit and said head motor drive circuit being coupled between  
14 said motor supply node and said second supply node;  
15 motor control logic coupled to said spindle motor drive circuit, said head motor  
16 drive circuit, and said selective isolation switching element, said control logic being configured  
17 to enter a regenerative braking state during normal operation wherein  
18 said selective switching element is controlled to isolate said spindle motor  
19 from said first voltage supply node;  
20 said spindle motor drive circuit and said head motor drive circuit are  
21 controlled to cause regenerative braking of the spindle motor so that kinetic energy due to  
22 rotation of the spindle motor is converted to electrical power that is supplied to the head  
23 motor.